November/December 2004

Office of Nonproliferation Research and Engineering (NA-22)
National Nuclear Security Administration

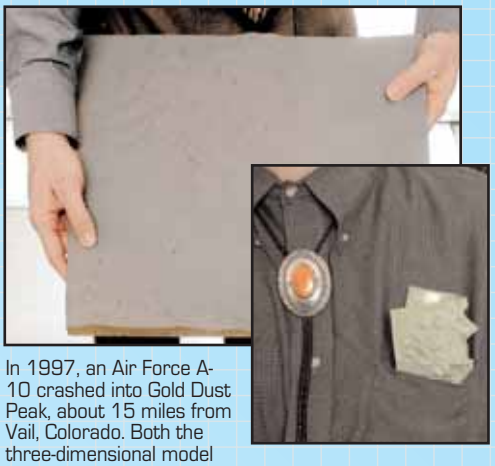
22 NEWS

Research Highlight: Synthetic Aperture Radar Addresses Nonproliferation Needs

NA-22 supports a world-class Synthetic Aperture Radar (SAR) program that develops and integrates a variety of technologies used by the nonproliferation community. SAR is a technique that generates detailed radar images using aircraft or satellite motion to create a *synthetic aperture* that simulates the performance of very large antenna (real aperture) radar systems. This technology can also be used by the Department of Defense, NASA, and other U.S. government agencies.

The more sophisticated SARs can obtain high-resolution radar images suitable for photo-interpretation. SARs can help identify objects as well as sense movement. They facilitate the determination of precise positions and so are quite useful for monitoring changes at observed locations. SARs can operate day and night and can see through clouds, rain, fog, dust, smoke, and to some extent, camouflage, foliage, and soil. In addition, *coherent processing techniques* for sophisticated data manipulation—not available to other types of imaging systems—lead to very enhanced capabilities. For instance, in some circumstances, it may be possible to identify the movement of objects on the ground, detect and analyze vibrations, and even sense very subtle displacements from one image to the next.

Applications range from environmental studies and commercial mapping to military planning and treaty verification. For nonproliferation purposes, new monitoring and detection methods using SAR could hypothetically provide the ability to discover disguised smokestacks or pipes around an illicit WMD site! Refining these additional capabilities has become increasingly essential for nonproliferation and national security.



In 1997, an Air Force A-10 crashed into Gold Dust Peak, about 15 miles from Vail, Colorado. Both the three-dimensional model (left) and a portable terrain map (in the shirt pocket) were interferometrically derived—interferometry is based on holographic principles and is a way of representing the phase differences between two images. The images are the product of the coherent processing of topographic data. The image was originally produced at the request of the Air Force using a DOE SAR that flew on a P-3 aircraft. The portable map guided members of the search teams as they looked for wreckage on the very rugged mountainside.

Radiochemistry Needed for Nonproliferation

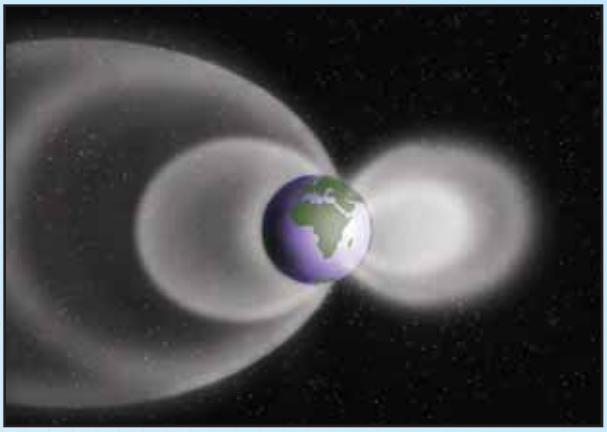
NA-22 has begun discussions about revitalizing the field of radiochemistry—both academically and professionally—in an effort to maintain strategic competency. Interested parties include the national laboratories and other federal agencies (the Department of Homeland Security, the National Science Foundation, and parts of the Department of Defense), as well as other organizations within DOE headquarters. Prudent planning for an NNSA of the future should address the projected shortage in trained radiochemists. Preserving scientific know-how (replete with the potential for R&D and innovation) in this crucial area should be a national security issue.

Radiochemistry as a science includes both the chemical and radiological properties of radioactive isotopes. Radiochemical techniques are the basis for the simple detection of special nuclear materials (weapon-usable radioisotopes of uranium and plutonium). Forensic science is possible because all radioactinides (any of the elements of that chemical series, not just uranium and plutonium) have an identifiable signature. This science is the key to a nuclear "CSI toolkit," offering clues to track would-be nuclear proliferators. Even though nuclear and physical chemistry, nuclear engineering, nuclear physics, and health physics all contribute to our general understanding of the atom, radiochemistry is crucial for nonproliferation specialists.

Therefore, reinvigorating radiochemistry addresses a real need. As the next generation of professionals, students must acquire expertise and training in radiochemistry and familiarize themselves with very specialized laboratory techniques and equipment. NA-22 specialists are currently developing processes and research topics that will be used to train new radiochemists to do lab work (with nonweapon-related materials) at their respective universities, so that in the future, they will use similar methodologies in classified applications to do real nonproliferation analysis at the national laboratories.

Kelvin Aaron operates a superconducting x-ray spectrometer under an NA-22-sponsored internship.

NA-22 Participates in Space and Environmental Effects Conference



The Van Allen radiation belts are regions of high-energy particles caused by the earth's magnetic field modifying the charged particles of cosmic radiation as it hits satellites in orbit, a principal topic of the SEEWG.

In November, NA 22's Robert Mayo and Eric Sander participated in the annual conference of the Space Environment and Effects Working Group (SEEWG) at the Aerospace Corporation in El Segundo, California. SEEWG was created by the Space Technology Alliance, an interagency group charged with coordinating the development of affordable and effective space technologies. SEEWG recommends projects to help understand and mitigate effects caused by natural phenomena on equipment deployed in space (for example, zero gravity, vacuum, and cosmic radiation). SEEWG provides a forum for developing a roadmap to create the infrastructure that will meet these critical needs. Besides Bob and Eric for NNSA, about 200 other participants represented the Air Force Research Laboratory, Defense Advanced Research Projects Agency, National Geospatial-Intelligence Agency, the National Reconnaissance Office, the Naval Research Laboratory, the National Aerospace and Space Administration, the Aerospace Corporation, as well as some of the national laboratories.

This year's theme was the special difficulties encountered by space-based radars (SBR). Plenary sessions on various topics related to space environmental effects on SBR were augmented by breakout sessions geared toward measuring and modeling the space environment, microelectronics, space structures, space power, and environment simulation facilities. In addition to identifying critical technology gaps and potential hardware and software needs, and promoting experiments and demonstrations, SEEWG works to determine the appropriate level of effort for particular requirements and fosters interagency collaboration to those ends.

Participants in the individual sessions developed notional roadmaps and presented these to a general meeting. Resulting recommendations will be summarized and presented to more senior management in each of the respective agencies that make up the Alliance. As an example, the principal representatives of the government program ultimately responsible for launching satellites that deploy sophisticated payloads (like the one developed as part of the NA-22's Cibola Flight Experiment, a multiyear effort to develop proliferation detection sensors) will be part of the audience for these briefings.

Rhys Williams Joins NA-22

NA-22 maintains a Proliferation Detection Program (PDP) whose mission is to provide the greater nonproliferation community, including related governmental entities, with the tools, technologies, and techniques and expertise necessary for the identification and characterization of facilities, materials, and processes of undeclared proliferant WMD programs and the diversion of nuclear materials.

As part of the recent re-organization within this office, Rhys Williams has been selected as the PDP Program Manager. Having just embarked on a strategic planning process, Rhys will lead PDP as NA-22 reformulates itself to build an NNSA of the future. Rhys has a B.S. in Engineering Physics from Miami University in Ohio. His advanced post-graduate education includes formal qualification as a nuclear-power plant manager through the Naval Nuclear Propulsion Program, an M.S. in Science, Technology, and Public Policy from the Elliot School of International Relations at the George Washington University, and a Ph.D. from the School of Public Policy, also at George Mason, with a specialty on the impact of science and technology on national policy. He was previously a Nuclear Weapons Officer for the U.S. Navy and has done post-graduate work through the Naval Nuclear Propulsion Program. He comes to us most recently from DOE's Office of Intelligence.

Rhys has been a member of a number of distinguished professional societies, including the AAAS, the IEEE, the U.S. Naval Institute, and the U.S. Submarine League. We are proud to have Dr. Williams in an important leadership position in NA-22.

22News
Publisher: Jan Cerveny, Assistant Deputy Administrator, NA-22

Editorial: Erich Pieper, NA-22
(202) 586-0112

Production: Gorgiana Alonzo, Kelly Spruiell, Kirk Hadley, and Nancy Rutter
Lawrence Livermore National Laboratory

National Nuclear Security Administration

M1099